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(54) Nonwoven fabric,process for producing the same and absorbent article using the same

(57) A liquid permeable nonwoven fabric having concealing properties and suitable for use as the topsheet of an absorbent article for personal wear comprises short fibers, 50% by weight or more being thermoplastic fibers, and has sealed areas (2) formed by partially sealing the fabric (1) so that the sealed area ratio is from 10 to 40%, the short fibers containing, based on 100 parts by weight of the fibers, from 1 to 5 parts by weight of titanium oxide, an aggregate web of the fibres having a wettability of from 3 to 20 seconds as expressed in terms of sedimentation time, and the fabric having a reflectance per unit basis weight of 1.3% or more. The sealing may be done by ultrasonic or heat embossing, eg with rolls and may be preceded by a hot air treatment. Bicomponent fibres are suitable.

FIG. 1

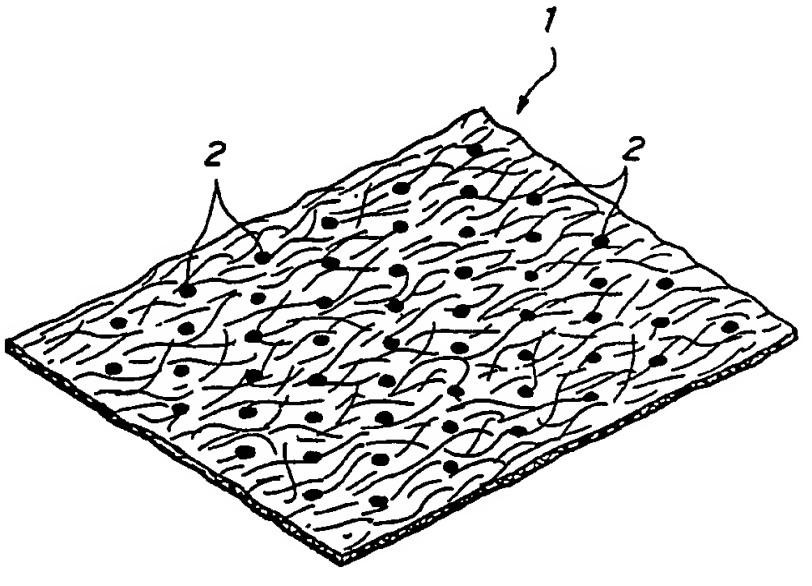

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FIG. 1

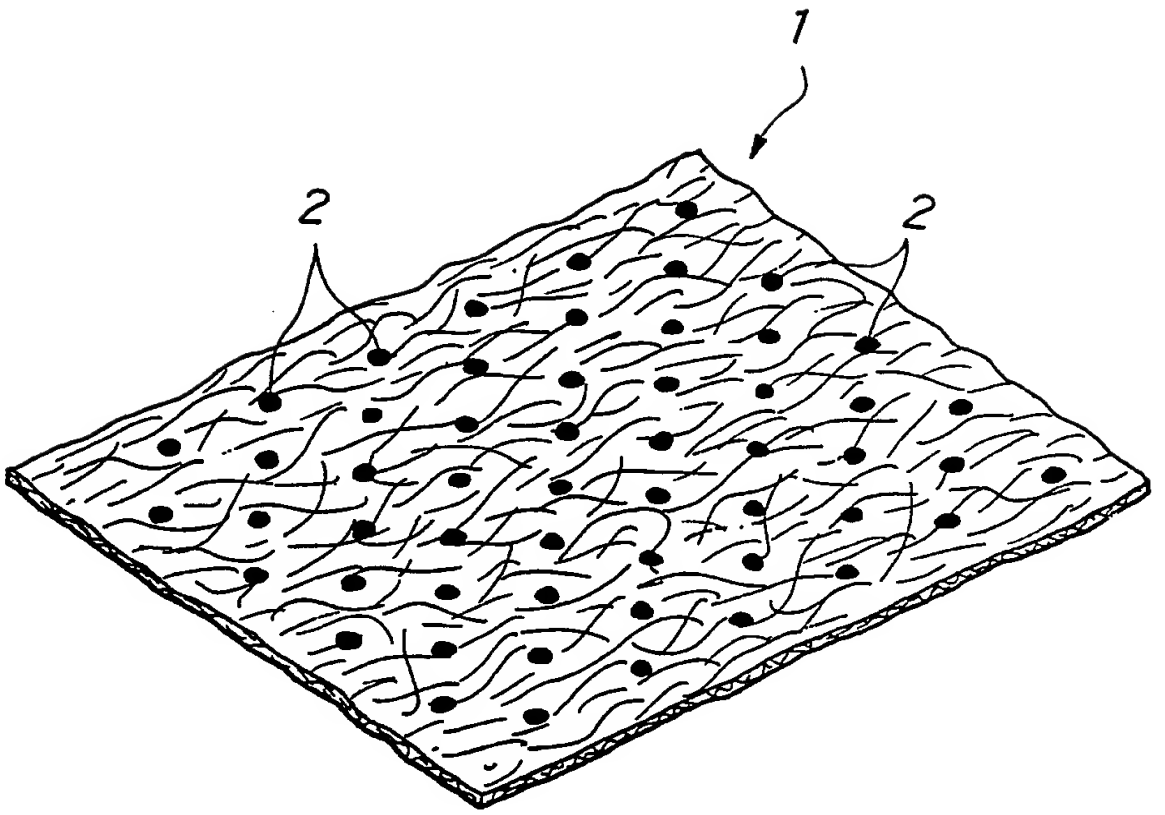


FIG. 2

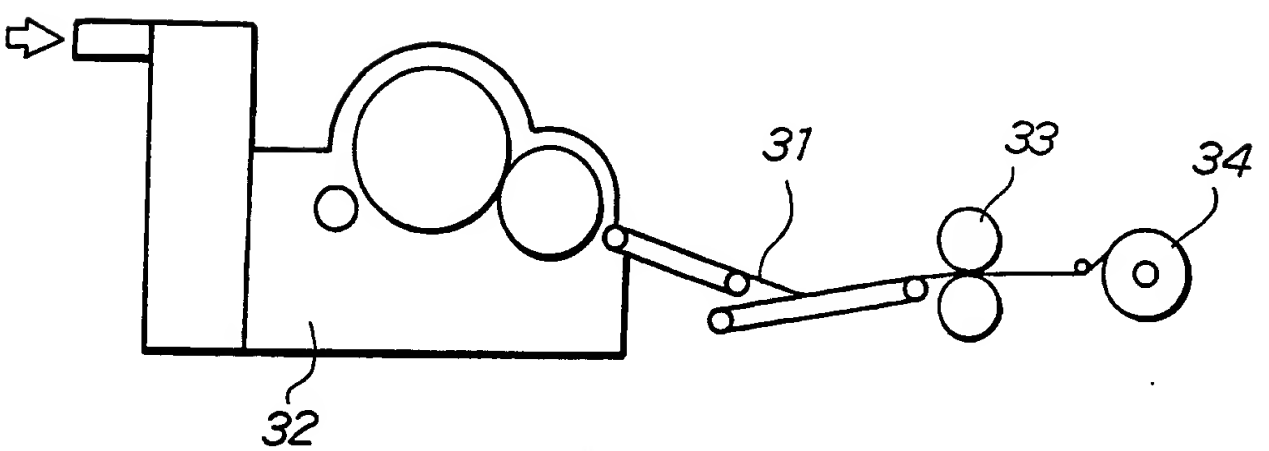


FIG. 3

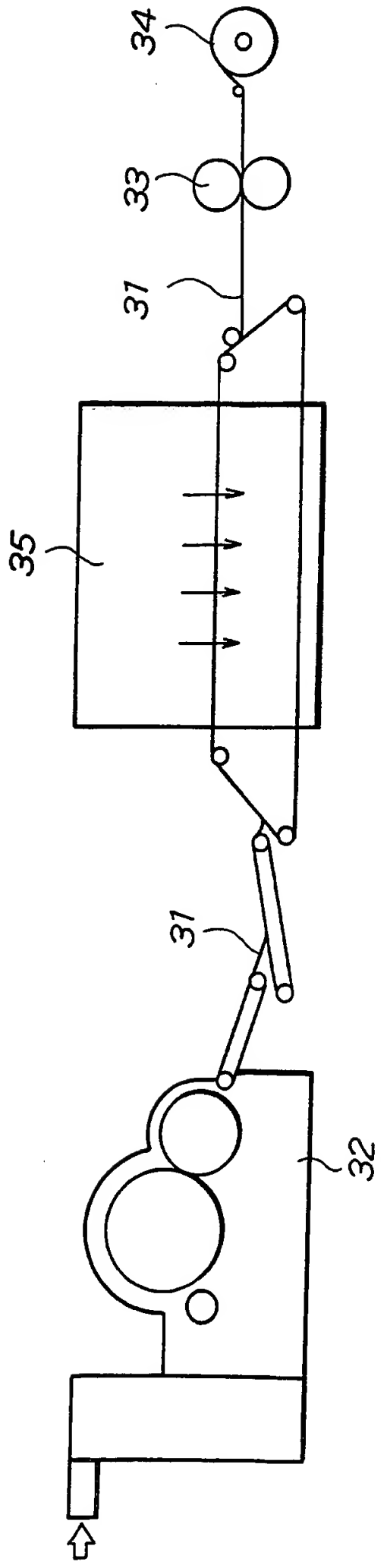


FIG. 4
(a)

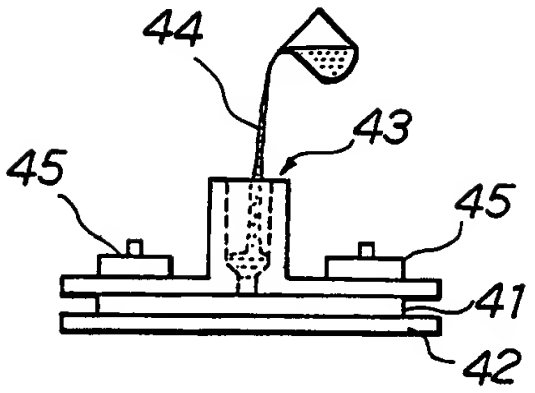


FIG. 4
(b)

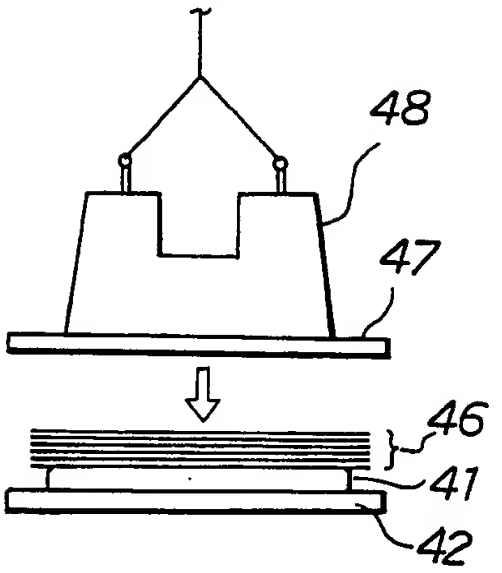


FIG. 5

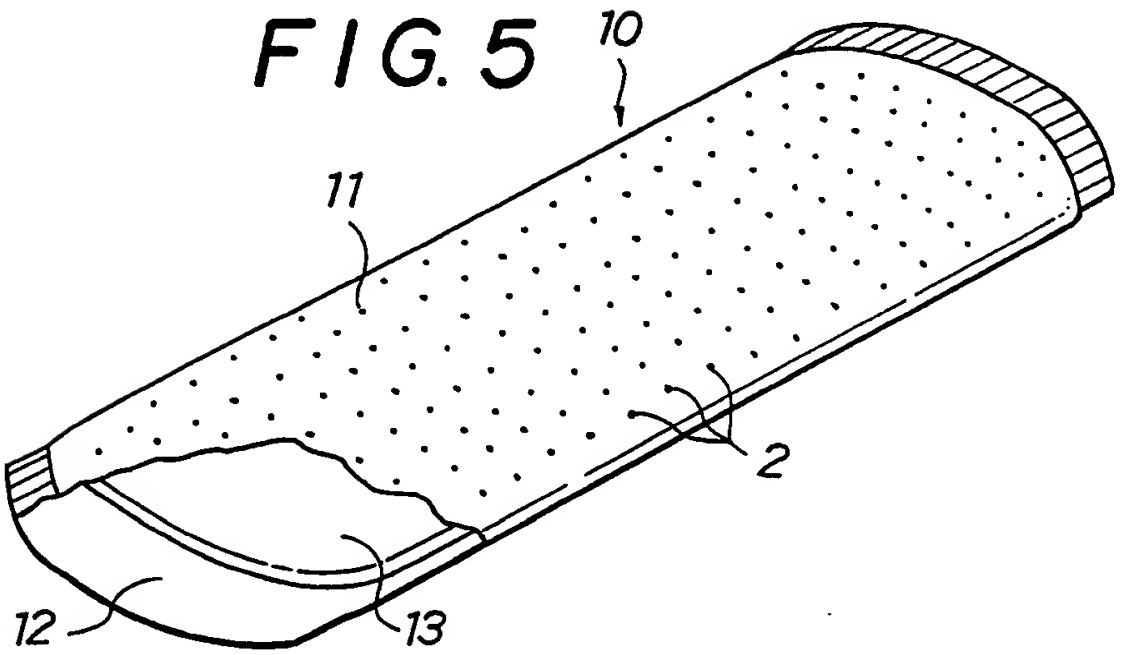


FIG. 6

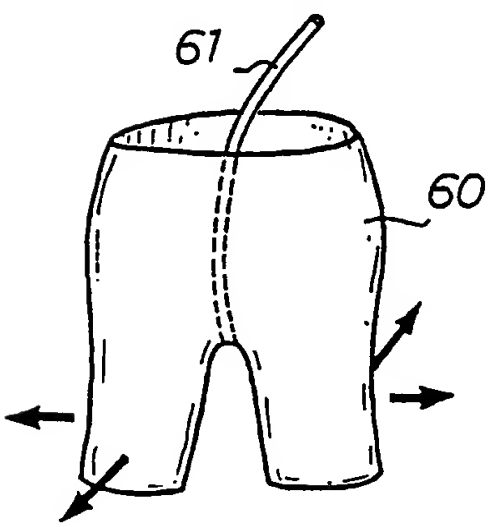
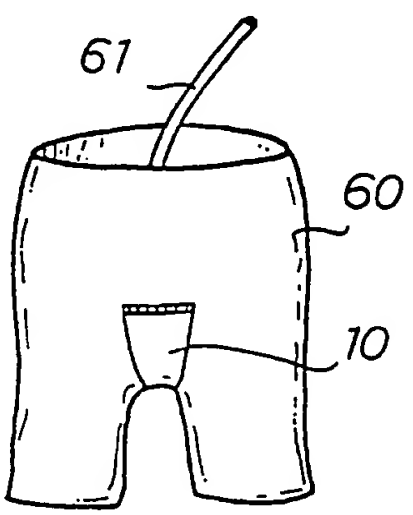


FIG. 7



NONWOVEN FABRIC, PROCESS FOR PRODUCING THE SAME, AND ABSORBENT ARTICLE USING THE SAME

BACKGROUND OF THE INVENTION

This invention relates to liquid permeable nonwoven fabric having concealing properties, a process for producing the nonwoven fabric, and an absorbent article using the nonwoven fabric. More particularly, it relates to liquid permeable nonwoven fabric having concealing properties which is suitable for use as a topsheet of an absorbent article such as a disposable diaper and a sanitary napkin, a process for producing the nonwoven fabric, and an absorbent article using the nonwoven fabric as a topsheet.

Materials which have been used as a topsheet of disposable diapers and sanitary napkins include nonwoven fabric such as thermal bonded nonwoven fabric having an improved dry feel and soft texture. In order to obtain a dry feel, films such as perforated films are also used as a topsheet of sanitary napkins.

However, conventional topsheets comprising a film or nonwoven fabric have the following disadvantages. (1) A topsheet comprising a film does not retain liquid because of no capillary structure but is considerably inferior to the one comprising nonwoven fabric

in feel while it is worn, giving discomfort to the wearer, such as a slimy, stuffy and sticky feel. (2) Although a topsheet comprising nonwoven fabric feels excellent while it is in dry state, it is inferior to the one comprising a film in feel while it is worn and wetted with a body fluid and in appearance after use.

In order to improve the dry feel of the topsheet comprising nonwoven fabric, Japanese Patent Application Laid-open 57-205506 proposes nonwoven fabric comprising fibers having an increased thickness so as to increase the capillary diameter thereby to reduce liquid retention therebetween. However, an absorbed body fluid such as menstrual blood is easily seen through the topsheet, giving an unpleasant appearance. In addition, this technique impairs the texture characteristic of nonwoven fabric.

Concealing properties are another important factor relating to improvement in practical utility of a topsheet comprising nonwoven fabric and in feel of dryness thereof. It has recently been demanded that a topsheet for use in absorbent articles has a function of concealing the color of absorbed liquid; for the coloration with a body fluid such as urine or blood affects the feeling of use.

It has been proposed to improve the concealing

properties of nonwoven fabric by increasing the TiO_2 content of the fiber to enhance a white tint, as disclosed in Japanese Patent Application Laid-open 61-45753. However, too a high TiO_2 content deteriorates spinnability of fibers, processability of fibers into a nonwoven fabric web, and fabricability of the resulting nonwoven fabric such as a cutting property, and is also uneconomical. Improvement of the concealing properties by reducing the fineness of fiber have been proposed, but mere reduction in fiber fineness brings about disadvantages of both production and function, that is, reduction in productivity of nonwoven fabric, reduction in rate of liquid permeation, and increase of oozing of an absorbed liquid. To increase a basis weight to improve the concealing properties has also been suggested, but this approach involves an increase of cost and the problem of liquid retention.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide nonwoven fabric excellent in liquid permeability and concealing properties which can be produced at low cost and high productivity and has excellent fabricability and, when used as a topsheet of an absorbent article, retains little liquid and feels satisfactory both to the touch during use and to the

eyes after use.

Another object of the present invention is to provide a process for producing the nonwoven fabric at high productivity.

A further object of the present invention is to provide an absorbent article using the nonwoven fabric as a topsheet, which article feels dry to the touch during use and looks dry even after use.

As a result of extensive investigations, the inventors of the present invention have found that application of a partial sealing technique by heat embossing to nonwoven fabric comprising fibers whose wettability is adjusted within a specific range and containing a specific amount of titanium oxide achieves the first object of the present invention, bringing about an improvement in concealing properties, providing liquid-repellent areas (sealed areas), providing completely concealing areas in proportion to the sealed area which keep the concealing function even after use, bringing about a great improvement in concealing properties at such a basis weight that does not lead to an increase of cost while satisfying the requirement of liquid absorbability as a topsheet of an absorbent article, and achieving a remarkable improvement in dry feel.

The present invention has been completed based on the above findings. The present invention provides liquid permeable nonwoven fabric having concealing properties which comprises short fibers, 50% by weight or more of said short fibers comprising thermoplastic fibers, and has sealed areas formed by partially sealing said nonwoven fabric in such a manner that the sealed area ratio is from 10 to 40 %,

said short fibers containing, based on 100 parts by weight of said short fibers, from 1 to 5 parts by weight of titanium oxide,

an aggregate web of said short fibers having a wettability of from 3 to 20 seconds as expressed in terms of sedimentation time, and

said nonwoven fabric having a reflectance per unit basis weight of 1.3% or more.

The present invention also provides a process of producing the above-mentioned nonwoven fabric in which the thermoplastic fibers are thermoplastic composite fibers, and the thermoplastic composite fibers are thermally bonded together at the crossing points thereof to form said nonwoven fabric, the process comprising:

subjecting a web of said short fibers to a hot-air treatment at a temperature not lower than the

melting point of the lower-melting component of said thermoplastic composite fibers and not higher than the melting point of the higher-melting component of said thermoplastic composite fibers to cause said thermoplastic composite fibers to be thermally bonded together at the crossing points thereof; and

subjecting the web to an embossing treatment at a temperature within 15 °C at or below the melting point of the lower-melting component, thereby accomplishing the second object of the present invention.

The present invention further provides an absorbent article comprising a topsheet facing the wearer's skin, a liquid impermeable back sheet, and an absorbent member interposed between the topsheet and the back sheet, the topsheet comprising the above-mentioned nonwoven fabric.

The nonwoven fabric of the present invention can be produced at low cost and high productivity and exhibits excellent liquid permeability and concealing properties, retains little liquid, and gives a comfortable feeling to the eyes. Specifically, it not only performs the functions possessed by conventional nonwoven fabric but, when used as a topsheet of an absorbent article, retains little liquid thereby exhibiting excellent property of concealing an absorbed body

fluid.

In the nonwoven fabric of the present invention where the thermoplastic fibers are thermoplastic composite fibers and the sealed areas are formed, the nonwoven fabric shows increased concealing properties, reduced amount of fluffing and coming out of the fibers, and exhibits improved smoothness and dry feeling.

According to the process of the present invention, the nonwoven fabric of the present invention can be produced at high productivity.

The absorbent article according to the present invention, in which the nonwoven fabric of the present invention is used as a topsheet, has an improved dry feel both to the touch during use and to the eyes after it is wetted.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of an embodiment of the nonwoven fabric according to the present invention;

Fig. 2 is a schematic illustration of an apparatus which can be used in the production of the nonwoven fabric of the present invention;

Fig. 3 is a schematic illustration of an apparatus which can be used in carrying out the preferred process for producing the nonwoven fabric of the pres-

ent invention;

Figs. 4(a) and 4(b) illustrate a device for measuring the absorption time and backflow of absorbed liquid;

Fig. 5 is a perspective view of a sanitary napkin as an embodiment of the present invention, in which the nonwoven fabric of the present invention is used as a topsheet;

Fig. 6 schematically shows a movable model of a female's waist portion; and

Fig. 7 schematically shows the model of Fig. 6 with the sanitary napkin of Fig. 5 applied.

DETAILED DESCRIPTION OF THE INVENTION

The nonwoven fabric of the present invention will be described below in detail.

The short fibers constructing the nonwoven fabric of the present invention comprises short fibers, 50% by weight or more of the short fibers comprising the thermoplastic fibers. A preferred mixing ratio of the thermoplastic fibers for stabilizing the physical properties and sealing properties of the resulting nonwoven fabric is from 70 to 100% by weight.

If the mixing ratio of the thermoplastic fibers is less than 50% by weight, the degree of sealing would be so low that the resulting fabric fails to meet the

physical requirements demanded during fabrication, such as strength and prevention of fluff from coming out.

The thermoplastic fibers which can be used in the present invention include polyester fibers, such as polyethylene terephthalate (PET) and polybutylene terephthalate (PBT); polyolefin fibers, such as polyethylene (PE) and polypropylene (PP); polyamide fibers, such as nylon 6 and nylon 66; and acrylic fibers. Since these thermoplastic fibers are essentially hydrophobic, they are usually subjected to a surface treatment with, for example, a surface active agent to improve wettability and processability.

The thermoplastic fibers are preferably thermoplastic composite fibers.

The thermoplastic composite fibers include core/sheath type composite fibers and side-by-side type composite fibers, comprising an appropriate combination of the above-enumerated thermoplastic fibers. In particular, composite fibers comprising two or more types of polymers different in melting point by 80 °C or more are preferably used.

Where the nonwoven fabric is used as a topsheet of sanitary napkins, composite fibers comprising PET as a core and PE as a sheath are particularly suitable for their functions and processability.

In using the above-mentioned thermoplastic composite fibers, the short fibers preferably consist of the thermoplastic composite fibers, whereby heat sealing may be conducted in a broader temperature range. As a result, troubles which may occur due to change of sealing temperature with change of running speed in the course of assembling the elements can be avoided, and the sealing strength is improved to improve the performance of the product.

The short fibers to be used in the nonwoven fabric contain from 1 to 5 parts by weight, preferably from 1.5 to 5 parts by weight, of TiO_2 per 100 parts by weight of the short fibers.

Incorporation of TiO_2 within the above range brings about improvement in concealing properties without impairing spinnability, nonwoven fabric productivity, and processability of nonwoven fabric. If the TiO_2 content is less than 1 part by weight, sufficient concealing properties cannot be obtained. If it exceeds 5 parts by weight, the spinning dope has poor spinnability, the fibers have poor processability, e.g., in carding, and the nonwoven fabric has poor fabricability, e.g., in cutting.

It is preferable that TiO_2 be localized in continuous lines along the longitudinal direction of

each fiber to form high density portions rather than uniformly distributed throughout the fiber. Where the short fibers consist of the above-mentioned thermoplastic composite fibers, it is preferable that TiO_2 be distributed only in the core than uniformly distributed in the core/sheath, with the constituting polymers, the fiber size, and the TiO_2 content being equal.

The short fibers preferably have a fiber size of 3 denier or less from the viewpoint of texture and concealing properties, and more preferably from 1.5 to 3 denier from the viewpoint of suitability to carding. The short fibers preferably have a fiber length of from 25 to 75 mm from the view point of suitability to carding.

An aggregate web of the short fibers have a wettability of from 3 to 20 seconds as expressed in terms of sedimentation time. In order to stabilize liquid permeability taking the balance between liquid oozing and the permeation rate into consideration, the sedimentation time is preferably 4 to 10 seconds.

If the sedimentation time is shorter than 3 seconds, the nonwoven fabric comprising such highly hydrophilic fibers causes serious liquid oozing and backflow similarly to the conventional nonwoven fabric. If the sedimentation time is longer than 20 seconds,

the nonwoven fabric exhibits poor liquid permeability and causes a liquid leak.

The term "aggregate web" as used herein refers to aggregate of short fibers obtained by carding.

The sedimentation time as above referred to can be measured in accordance with the criteria specified for sanitary goods, "dewaxed cotton" (absorbent wadding) (published by Nihon Eisei Zairyo Kogyokai on September 1, 1966 under the supervision of Pharmaceutical Affairs Division, Japanese Health and Welfare Ministry).

The sedimentation time can be adjusted to the above range by optimizing the coverage of a surface active agent (finishing agent) applied to the surface of fibers while appropriately selecting the contact angle to water and the surface energy of the surface active agent. For example, when the surface active agent is applied to the surface of the fibers which constitute the nonwoven fabric of the present invention, known surface agnets such as alkyl phosphate and alkyl ether sulfate can be used while adjusting the formulation, modification and coverage of the surface active agent so that the sedimentation time may fall within the above range.

The nonwoven fabric of the present invention

comprising the above-described short fibers has sealed areas formed by partially sealing said nonwoven fabric in such a manner that the sealed area ratio from 10 to 40%, based on the total area of the nonwoven fabric. For good balance between reduction in the area where liquid is retained (enhancement in concealing properties) and texture, a preferred sealed area ratio is 20 to 30%.

If the sealed area ratio is less than 10%, the nonwoven fabric is unsatisfactory in strength during use or processing, property of concealing a body fluid, and, in particular, reduction in the area where liquid is retained. If the sealed area ratio exceeds 40%, although the area where liquid is retained is sufficiently reduced to show very high concealing properties, the liquid permeation rate is too low for practical use, and the texture such as feel to the touch and softness is significantly impaired.

Although the sealed area may be in the state that the thermoplastic fibers or the lower-melting components of the thermoplastic composite fibers are melt or not melt together, or the fibers retain their forms, it has a sealed structure which does not substantially retain liquid.

A preferred sealed area ratio of the nonwoven

fabric for obtaining a dry appearance as a topsheet of absorbent articles is preferably 20% or more, still preferably 30% or more. However, since a concealing function and a liquid permeation function conflict with each other, and also an increase in sealed area ratio results in hardness, a recommended sealed area ratio for that use ranges from 20 to 30%. A concealing function and a liquid permeation function are preferably well balanced by adjusting the fiber size of the short fibers and the basis weight of the nonwoven fabric within their preferred range hereinafter described.

The nonwoven fabric of the present invention preferably has a reflectance of 20% or more, still preferably 30% or more, for assuring a satisfactory dry feel as a topsheet.

The reflectance of the nonwoven fabric per unit basis weight (1 g/m^2) is 1.3% or more, preferably 1.4% or more.

If the reflectance per unit basis weight is less than 1.3%, a body fluid absorbed in an absorbent member is easily seen through the topsheet, or a required basis weight would be uneconomically high.

A method for measuring the reflectance will be described later.

The nonwoven fabric of the present invention preferably has a basis weight of from 15.5 to 35 g/m^2. From the viewpoint of the cost and the balance between the concealing properties and the absorptivity, a still preferred basis weight is from 20 to 30 g/m^2.

In other words, a high basis weight is advantageous for prevention of liquid backflow from an absorbent member and for improvement of the concealing properties but seriously disadvantageous for quick liquid permeation, prevention of liquid remaining, and especially cost.

While whitening of a topsheet for improvement in the concealing properties is a known technique, the content of TiO_2 that may be incorporated into the nonwoven fabric of the present invention is limited as has been the case with the conventional nonwoven fabric.

In the present invention, even with the TiO_2 content being controlled low as specified above, the nonwoven fabric having sealed areas possesses liquid permeability required for use as a topsheet of absorbent articles while satisfying various physical properties required as nonwoven fabric. Additionally, the sealed areas do not retain liquid, rather repelling liquid, and keep exhibiting concealing properties and

whiteness. Therefore, the nonwoven fabric of the present invention, when used as a topsheet of absorbent articles, exhibits a greatly improved concealing properties and a substantial dry feel even after being wetted as compared with nonwoven fabric having no sealed area.

Because of the sealed areas formed by partial sealing, the nonwoven fabric of the present invention has a decreased room for retaining liquid while maintaining the body fluid permeating function.

Nonwoven fabric having such a structure formed by so-called heat embossing has hitherto been supplied. However, nonwoven fabric having sealed areas formed by heat embossing becomes less bulky and is liable to cause considerable liquid oozing and backflow.

To the contrary, the nonwoven fabric of the present invention, because of the specific wettability of constituting fibers and the specific TiO_2 content, inhibits liquid oozing or backflow while maintaining liquid permeability and shows a markedly improved property of concealing an absorbed body fluid from view when used as a topsheet of absorbent articles.

In particular, since the nonwoven fabric of the present invention has its TiO_2 content limited within a specific range and has sealed areas at a specific area

ratio, it satisfactorily performs a function of liquid absorption while repelling liquid at the sealed areas, thereby reducing the proportion of the area that retains the liquid. As a result, it has a remarkably improved concealing properties and an improved dry feel on practical use as compared with nonwoven fabric having its TiO_2 content merely increased.

As previously stated, conventional nonwoven fabric comprising fibers having been rendered hydrophilic is so wettable that it is ready to reduce the space between the fibers and become less bulky on being wetted, tending to cause liquid oozing or backflow. On the other hand, the nonwoven fabric of the present invention whose wettability is controlled within a specific range does not lose its bulkiness to such a degree as causes liquid oozing or backflow.

By virtue of the aforesaid characteristics, the nonwoven fabric of the present invention fulfills its function as a topsheet of absorbent articles with a substantially low basis weight, i.e., letting a body fluid such as menstrual blood penetrate therethrough, while reducing the portion retaining the body fluid so as to conceal the absorbed body fluid from view, without involving such economical disadvantages as a mere increase in basis weight for improving the concealing

properties or without reducing the fiber size of the constituting fibers to such an extent that would result in difficulty in carding.

The nonwoven fabric of the present invention in which the thermoplastic fibers are thermoplastic composite fibers and the thermoplastic composite fibers are thermally bonded together at the crossing point is preferred to the one in which the fibers are not thermally bonded together; for the former structure is more effective to prevent fibers from fluffing or coming out.

It is preferable for further improving the concealing properties that the sealed areas of the nonwoven fabric of the present invention are caused to be cloudy so that the nonwoven fabric has a reflectance per unit basis weight increased to 1.4% or higher.

The nonwoven fabric of the present invention may have either a single layer structure solely comprising a web of the above-mentioned short fiber or a laminated structure comprising a plurality of the webs. The laminated structure may comprise two or more different types of webs in such a manner that the layer facing the wearer's skin and the layer farthest from the wearer's skin differ in types, fiber size, mixing ratio, etc. of constituting fibers.

The nonwoven fabric according to the present invention will be illustrated more specifically by referring to Fig. 1. Fig. 1 is a perspective view of an embodiment of the nonwoven fabric according to the present invention.

A nonwoven fabric 1 shown in Fig. 1 has a single layer structure comprising a web of the above-described short fibers. It has sealed areas 2 in the form of dots.

The sealed areas 2 are preferably formed in dots as in Fig. 1 from the standpoint of appearance and softness, but are not particularly limited in shape.

The area of each sealed area and the density of the sealed areas are not particularly restricted as far as the above-specified sealed area ratio is satisfied. However, the area of each sealed area preferably ranges from 0.5 to 12.6 mm^2, and the density of the sealed ares ranges from 2 to 30 sealed areas per cm^2.

The sealed areas are preferably formed in a non-melt state and are thereby caused to be cloudy for obtaining improved concealing properties and for prevention of fluffing.

The nonwoven fabric of the present invention can easily be obtained by making the above-described short fibers into a fiber web in a conventional manner

and subjecting the web or a laminate thereof to embossing.

For example, the nonwoven fabric can be prepared as illustrated in Fig. 2. In Fig. 2 is shown a schematic illustration of an apparatus which can be used in the production of the nonwoven fabric of the present invention. Short fibers are fed to a carding machine 32 as shown by the arrow and carded into a web 31. The web 31 is fed to embossing rolls 33 where it is partially sealed by heat embossing, taken off by a winder 34, and cut and trimmed to desired shape and size to obtain the nonwoven fabric of the present invention.

The web can be obtained by well-known techniques, for example, carding. The embossing can be carried out in a conventional method, such as heat embossing or ultrasonic embossing, in which embossing is effected at a temperature higher than the melting point of the thermoplastic fibers to give a pattern, e.g., a dot pattern, having a sealed area ratio of 10 to 40%. When the thermoplastic fibers are thermoplastic composite fibers, and the lower-melting component thereof has a melting point, e.g., of 132 °C, the embossing is carried out at an embossing temperature of 140 to 145 °C under a pressure of 30 to 45 kg/cm.

The preferred nonwoven fabric of the present invention having excellent concealing properties and freedom from fluffing, in which the thermoplastic fibers are thermoplastic composite fibers and the thermoplastic composite fibers are thermally bonded together at the crossing point, can be prepared by subjecting a web comprising the above fibers to a hot-air treatment at a temperature not lower than the melting point of the lower-melting component of the thermoplastic composite fibers and not higher than the melting point of the higher-melting component of the thermoplastic composite fibers to cause the thermoplastic composite fibers to be thermally bonded together at the crossing point thereof and subjecting the web to embossing at a temperature within 15 °C at or below the melting point of the lower-melting component.

More specifically, the preferred nonwoven fabric can be produced as shown in Fig. 3. In Fig. 3 is shown a schematic illustration of an apparatus which can be used in carrying out the preferred process for producing the nonwoven fabric of the present invention. Short fibers are fed to the carding machine 32 as shown by the arrow and carded into the web 31. The web 31 is fed to heat treating machine 35 where hot air is supplied in the direction shown by the arrows and is

applied to the web 31 to thermally bond the thermoplastic fibers (melting component) of the web 31. The heat-treated web 31 is then fed to the embossing rolls 33 where it is partially sealed by heat embossing, taken off by the winder 34, and cut and trimmed to desired shape and size to obtain the nonwoven fabric of the present invention.

Embossing at a temperature within the above-specified range makes it possible to form sealed areas exhibiting cloudiness without completely melting the sealed areas.

If the embossing temperature exceeds the melting point, the sealed areas undergo complete melting and do not assume cloudiness. If the temperature is lower than the melting point by more than 15 °C, the sealed areas are seemingly cloudy but have poor shape retention and tend to disintegrate during use.

The nonwoven fabric produced by the above-mentioned preferred process exhibits further enhanced concealing properties, effectively prevents fibers from fluffing or falling out, and has an improved dry feel. That is, physical properties required as nonwoven fabric can be assured and fluffing of the constituting fibers can be inhibited by thermally bonding the thermoplastic composite fibers having a specific TiO_2

content at the crossing points among themselves.

Describing the above process more specifically, it is preferable for texture to lower the temperature of hot air in the hot-air treatment in inverse proportion to the mixing ratio of the thermoplastic component in the thermoplastic composite fibers, taking it into consideration that the heat treated web is to be subsequently subjected to heat embossing. Generally, the hot-air treatment is preferably carried out at 132 to 140 °C for 6 to 10 seconds.

The conditions of embossing are arbitrarily selected according to the desired sealed area ratio. For obtaining the sealed area ratio of, for example, 25%, an embossing pressure recommended for forming cloudy sealed areas and for ensuring satisfactory physical properties as nonwoven fabric is from 15 to 60 kg/cm, preferably from 30 to 50 kg/cm, in terms of linear pressure. If the linear pressure exceeds 60 kg/cm, the sealed areas tend to suffer from damage, resulting in reduction in strength. If it is less than 15 kg/cm, the sealing tends to be nonuniform and incomplete. Taking thermoplastic composite fibers composed of PET as a core and PE as a sheath for instance, the PE sheath having a melting point of 135 °C, the embossing temperature is preferably selected from the range

of 120 to 135 °C.

The above-mentioned process includes a hot-air treatment for thermally bonding thermoplastic composite fibers together to endow the short fiber web with physical properties as a nonwoven fabric and an embossing treatment for forming cloudy sealed areas.

Without thermal bonding by the hot-air treatment, the resulting nonwoven fabric hardly satisfies the requirements of physical properties such as strength; for the embossing conditions adopted in the above-mentioned process are intentionally made milder than those used in conventional processes for nonwoven fabric manufacturing; that is, the embossing conditions of the present invention are not sufficient for stably imparting sufficient physical properties such as strength required as nonwoven fabric to the web.

The cloudiness of sealed areas is attributed to irregular reflection due to microscopic strains and cracks caused by embossing. Therefore, cloudy sealed areas have notably increased concealing properties as compared with heat-embossed sealed areas in which fibers have undergone complete thermal bonding.

In conventional techniques of producing nonwoven fabric by heat embossing, processing at a temperature causing thermal bonding has been essential for

assuring necessary strength as nonwoven fabric. For example, thermoplastic fibers having a melting point of 132 °C are usually embossed at 140 to 145 °C. Since cloudy sealed areas cannot be formed without sacrificing physical properties such as strength as nonwoven fabric, it is impossible to manufacture nonwoven fabric with cloudy sealed areas by conventional heat embossing. It is not until an embossing treatment is preceded by a hot-air treatment that cloudy sealed areas can be formed while satisfying physical requirements essential to nonwoven fabric.

When incorporating the nonwoven fabric into the absorbent article of the present invention, the machine direction (MD) of the nonwoven fabric and the longitudinal direction of the absorbent article may be the same or different.

The absorbent articles according to the present invention will be described below.

The absorbent article of the present invention comprises a topsheet facing the wearer's skin, a liquid impermeable back sheet, and an absorbent member interposed between the topsheet and the back sheet, the topsheet comprising the nonwoven fabric of the present invention. By virtue of the characteristics of the nonwoven fabric as a topsheet, the absorbent article of

the present invention has not only high absorptivity but high concealing properties so that the absorbed body fluid, such as urine or blood, may not be easily seen through. Since the sealed areas of the topsheet do not retain a body fluid, the absorbent article feels very dry and causes no discomfort to the wearer both physically and visually.

The absorbent articles of the present invention are applicable to all the ordinary absorbent articles such as disposable diapers and sanitary napkins, and are especially suitable as sanitary napkins as shown in Fig. 5. A sanitary napkin 10 shown in Fig. 5 comprises a topsheet 11 facing the wearer's skin, a liquid imper-meable back sheet 12, and an absorbent member 13 interposed between the topsheet and the back sheet, the topsheet comprising the nonwoven fabric. Any of well-known back sheets and absorbent members may be used in the absorbent articles of the present invention without any particular limitation.

The nonwoven fabric according to the present invention satisfies the requirements for use as a topsheet of absorbent articles, i.e., permeability to body fluids and non-retention of the absorbed body fluid, without incurring an increase in cost. It is particularly excellent in concealing properties and dry

feel, causing no discomfort to the wearer. Accordingly, the absorbent article of the present invention exhibits a great reduction in slimy feel on the topsheet surface during use and a greatly improved property of concealing the absorbed body fluid, such as menstrual blood. Therefore, it is excellent in feel of use both physically and visually.

The present invention will now be illustrated in greater detail with reference to Examples and Comparative Examples, but the present invention is not deemed to be limited thereto.

EXAMPLES 1 to 21

Short fibers, whose composition is shown in Table 1, were carded into a web having the basis weight shown in Table 2. The resulting web was embossed under the conditions shown in Table 2 to obtain nonwoven fabric (Examples 1 to 21 and Comparative Examples A to I, K, and N). In Examples 16 to 20, the web was subjected to a hot-air treatment under the conditions shown in Table 2 prior to the embossing. The sealed area ratio and reflectance per unit basis weight of the resulting nonwoven fabric are shown in Table 1. Comparative Example I could not made into nonwoven fabric because it had not been subjected to a hot-air treatment and had been embossed at a temperature lower than

the melting point of PE. Comparative Example K is nonwoven fabric having no sealed area. The non-thermoplastic fibers shown in Table 1 refer to the fibers having a melting point of 200 °C or higher.

The reflectance per unit basis weight as referred to above was measured as follows.

Reflectance:

Reflectance was measured with a differential colorimeter SZG-d80, manufactured by Nippon Denshoku Kogyo K.K., under the conditions described below and calculated according to the following equation. The reflectance per unit basis weight was obtained by dividing the reflectance thus obtained by the basis weight of the nonwoven fabric.

Measuring Conditions:

Diameter of the measurement of the position: 30 mm (the internal lens was changed accordingly)

Number of measurements: 10 positions per sample

Wavelength: 500 nm

Equation:

$$\text{Reflectance (\%)} = [(r - r_0)/(100 - r_0)] \times 100$$

r : Measured value of sample

r_0: Measured value of a standard red plate

Each of the samples obtained (Examples 1 to 21 and Comparative Examples A to I, K and N) was evaluated

in terms of strength, texture, fluffing, absorption time, appearance after absorption, fabricability (e.g., heat sealing property), backflow of absorbed liquid, spinnability and processability of fibers into nonwoven fabric, and dynamic absorption and also evaluated for cost performance. These characteristics of the samples were then totally judged. The results obtained are shown in Tables 3 through 6.

The above measurement, evaluation, and overall judgement were made as follows.

Strength (g/50 mm):

Ten test pieces having 200 mm in length and 50 mm in width whose longitudinal direction agrees with the machine direction (hereinafter referred to as MD samples) and 10 test pieces, having the same size as the MD samples, whose longitudinal direction agrees with the transverse direction crossing the machine direction (hereinafter referred to as TD) were cut out from the nonwoven fabric. A tensile test was conducted using a Tensilon tensile tester RTA-100, manufactured by Orientec Co., at a distance of 150 mm between chucks and at a rate of elongation 6f 300 mm/min to measure the maximum stress at break.

Absorption Time and Backflow:

Absorbent paper having a pulp density of 0.06

to 0.1 g/cm^3 and a basis weight of 33 g/m^2 was cut into pieces having 160 mm in length and 65 mm in width. A pile of about 20 cut pieces of the paper totally weighing about 7 g was used as a test absorbent member. A colored liquid having a viscosity of from 1 to 10 cp was prepared as a test liquid which simulates menstrual blood or urine. An absorption test was conducted using the device shown in Figs. 4 (a) and 4(b), which schematically show a device for measuring absorption time and a device for measuring backflow respectively, in accordance with procedures (1) to (6) described below:

(1) As shown in Fig. 4(a), a sample 41 made of the absorbent member wrapped in test nonwoven fabric was placed on an acrylic plate 42, a cell 43 for liquid pouring was put thereon, and weights 45 were put on the cell to impose a pressure of 5 g/cm^2 on the absorbent member.

(2) Ten grams of the test liquid was poured into the cell 43, and the time period from the moment for the test liquid first to reach the surface of the sample to the moment for all the test liquid to be absorbed in the sample was taken as an absorption time.

(3) As shown in Fig. 4(b), after 4 minutes from the moment for the test liquid first to reach the surface

of the sample, the cell 43 and the weights 45 were taken away, and 10 piles of No. 2 filter paper 46 (80 mm x 190 mm) weighing W1 (g) were gently placed on the sample.

(4) The weight 48 to which the acrylic plate 47 was fixed was softly put on the filter paper 46 so as to apply a pressure of 50 g/cm^2. The pressure was maintained for 3 minutes.

(5) The load was removed after 3 minutes' pressure application, and the wetted weight W2 (g) of the filter paper 46 was measured.

(6) The difference in weight of the filter paper 46 (W1 - W2)g was taken as the amount of backflow.

Texture, Fluffing and Appearance After Absorption

Texture and Fluffing:

The texture and fluffing of test nonwoven fabric were evaluated through an organoleptic test by 20 female panel members. The points given according to the following rating system were added up and divided by the number of the panel members (n=20) to obtain an average point as a criterion of evaluation. An average point with a decimal fraction is rounded up or down to obtain a round figure.

2 (E) ... Very satisfactory for practical use

1 (G) ... Satisfactory for practical use

0 (F) ... Acceptable for practical use

-1 (P) ... Unacceptable for practical use

Appearance After Absorption:

Sanitary napkins employing nonwoven fabric to be tested as a topsheet were used by 10 females and evaluated for appearance after use according to the following rating system. The test results were processed in the same manner as in the evaluation of texture and fluffing. When the napkin is unsatisfactory for practical use, it is evaluated as poor.

2 (E) ... Keeps blood nearly concealed from view, feeling highly dry as compared with conventional napkins.

1 (G) ... Keeps blood nearly concealed from view, feeling slightly dry as compared with conventional napkins.

0 (F) ... The same appearance as conventional napkins.

-1 (P) ... Blood is easily seen through.

Fabricability:

Fabricability of nonwoven fabric in conveyance, cutting, heat sealing, high-speed assembly, and the like in the conversion to final products was totally evaluated according to the following rating system.

E ... Very suitable to fabrication (high

productivity).

G ... Suitable to fabrication more than usual.

F ... Troubles occur to some extent (low productivity).

P ... Unsuitable to fabrication (no productivity).

Dynamic Absorption:

The topsheet 11 comprising nonwoven fabric and having sealed areas 2, the back sheet 12 comprising liquid impermeable film, and the absorbent member 13 comprising fluff pulp, a blotting paper and a superabsorbent polymer were fabricated into the sanitary napkin 10 shown in Fig. 5.

As shown in Fig. 7, the resulting napkin was fitted to a movable model 60 of a female's waist portion shown in Fig. 6, and shorts were put thereon. The model was moved to simulate walking at a speed of 100 steps/min (50 m/min). After 1 minute from the start of the movement, 2 g of defibrinated horse blood was discharged into the napkin by pouring it through a tube 61 at a rate of 8 g/min while moving the model. Three minutes later, 3 g of the same blood was discharged while moving the model. Three minutes later, 2 g of the same blood was discharged while moving the model.

Thereafter, the procedure of 3 minutes' moving followed by discharging of 2 g of the blood while moving the model was repeated, and the total amount of the blood discharged at the moment when a leak occurred was recorded. The test was repeated 10 times per sample, and the results were averaged to obtain a dynamic absorption.

Spinnability and Processability:

Spinnability and processability of the fibers into nonwoven fabric were totally judged as follows.

G ... No problem

F ... Slightly questionable

P ... Unsuitable for production

Cost Performance:

The cost performance of nonwoven fabric was evaluated in terms of basis weight vs. concealing power (reflectance) according to the following standard.

G ... Reflectance per unit basis weight of 1.3% or higher and the basis weight of 30 g/m^2 or less.

F ... Reflectance per unit basis weight of 1.3% or higher and the basis weight of more than 30 g/m^2 and 35 g/m^2 or more.

P ... Reflectance per unit basis weight of

lower than 1.3% and the basis weight of 25 g/m^2 or more.

Overall Judgement:

The sample of nonwoven fabric was given an overall grade based on the productivity, fabricability, physical properties, and practical performance.

E ... Substantially very satisfactory.

G ... Substantially satisfactory.

F ... Substantially practical.

P ... Substantially impractical.

TABLE 1

		Composition of Short Fibers						TiO_2 Content (wt%)	Sedimentation Time (sec)	Sealed Area Ratio (%)	Reflectance Per Unit Basis Weight (%)
		Thermoplastic Fibers			Non-thermoplastic Fibers						
		Core/ Sheath	Fiber size ×Length (d×mm)	Mixing ratio (%)	—	Fiber size ×Length (d×mm)	Mixing ratio (%)				
Examples	1	PET/PE	2×51	100	—	—	—	2.5	5.6	10	
	2	PET/PE	2×51	100	—	—	—	2.5	5.6	25	1.7
	3	PET/PE	2×51	100	—	—	—	2.5	5.6	25	1.4
	4	PET/PE	2×51	100	—	—	—	2.5	5.0	40	
	5	PET/PE	2×51	50	PET	2×51	50	2.5	4.8	40	
	6	PET/PE	2×51	70	PET	2×51	30	2.5	5.1	25	1.5
	7	PET/PE	2×51	100	—	—	—	1.0	5.6	10	1.3
	8	PET/PE	2×51	100	—	—	—	1.0	5.6	25	1.3
	9	PET/PE	2×51	100	—	—	—	1.0	5.6	25	1.3
	10	PET/PE	2×51	100	—	—	—	1.5	5.6	25	1.6
	11	PET/PE	2×51	100	—	—	—	1.5	5.6	25	1.5
	12	PET/PE	2×51	100	—	—	—	5.0	5.6	25	2.2
	13	PET/PE	2×51	100	—	—	—	2.5	3.3	25	
	14	PET/PE	2×51	100	—	—	—	2.5	11.2	25	
	15	PET/PE	2×51	100	—	—	—	2.5	18.8	25	
	16	PET/PE	2×51	100	—	—	—	2.5	5.6	25	1.6
	17	PET/PE	2×51	100	—	—	—	2.5	5.6	40	1.9
	18	PET/PE	2×51	70	PET	2×51	30	2.5	5.1	40	1.8
	19	PET/PE	2×51	100	—	—	—	1.0	5.6	25	1.5
	20	PET/PE	2×51	100	—	—	—	1.5	5.6	25	1.5
	21	PP/PE	2×51	100	—	—	—	2.5	5.0	25	1.4
Comparative Examples	A	PET/PE	2×51	100	—	—	—	2.5	5.6	7	
	B	PET/PE	2×51	50	PET	2×51	50	2.5	4.8	50	
	C	PET/PE	2×51	30	PET	2×51	70	2.5	4.5	40	
	D	PET/PE	2×51	100	—	—	—	0.5	5.6	25	1.0
	E	PET/PE	2×51	100	—	—	—	0.5	5.6	25	1.1
	F	PET/PE	2×51	100	—	—	—	7.0	5.6	25	2.3
	G	PET/PE	2×51	100	—	—	—	2.5	1.8	25	
	H	PET/PE	2×51	100	—	—	—	2.5	22	25	
	I	PET/PE	2×51	100	—	—	—	2.5	5.6	25	1.5
	K	PET/PE	2×51	100	—	—	—	2.5	5.6	—	1.5
	N	PP/PE	2×51	100	—	—	—	2.5	5.0	7	

TABLE 2

		Melting Point of PE Sheath (℃)	Basis Weight (g/m²)	Hot-air Treatment		Embossing		Melting Point of Core PET or PP (℃)
				Temp. (℃)	Time (sec)	Temp. (℃)	Linear Pressure (kg/cm)	
Examples	1	132	16.1	–	–	145	35	255
	2	132	17.4	–	–	145	35	255
	3	132	25.2	–	–	145	35	255
	4	132	15.8	–	–	145	35	255
	5	132	21.2	–	–	145	35	255
	6	132	20.5	–	–	145	35	255
	7	132	16.3	–	–	145	35	255
	8	132	17.6	–	–	145	35	255
	9	132	32.3	–	–	145	35	255
	10	132	16.0	–	–	145	35	255
	11	132	20.4	–	–	145	35	255
	12	132	17.0	–	–	145	35	255
	13	132	25.4	–	–	145	35	255
	14	132	24.8	–	–	145	35	255
	15	132	24.6	–	–	145	35	255
	16	132	25.9	133	9	120	35	255
	17	132	24.4	133	9	120	35	255
	18	132	24.9	133	9	120	35	255
	19	132	26.2	133	9	120	35	255
	20	132	25.5	133	9	120	35	255
	21	132	24.4	–	–	145	35	160
Comparative Examples	A	132	16.7	–	–	145	35	255
	B	132	20.6	–	–	145	35	255
	C	132	20.1	–	–	145	35	255
	D	132	17.2	–	–	145	35	255
	E	132	38.3	–	–	145	35	255
	F	132	17.4	–	–	145	35	255
	G	132	25.6	–	–	145	35	255
	H	132	24.9	–	–	145	35	255
	I	132	26.1	–	–	120	35	255
	K	132	24.7	133	9	–	–	255
	N	132	17.9	–	–	145	35	160

Table 3

		Basis Weight (g/m^2)	Strength (kg/50mm) MD	Strength (kg/50mm) TD	Reflectance (%)	Absorption Time (sec)	Texture	Fluffing	Appearance After Use	Fabricability	Overall Judgement
Examples	1	16.1	1.2	0.2	26.2	26	G	G	F	F	F
	2	17.4	1.9	0.4	28.8	28	G	G	F	G	G
	4	15.8	2.7	0.5	27.9	33	F	G	F	G	F
	5	21.2	1.3	0.2	31.3	30	G	F	G	F	F
	6	20.5	1.7	0.3	30.4	24	G	F	G	F	G
	3	25.2	3.0	0.6	34.9	28	G	G	G	G	G
	21	24.4	3.0	0.7	35.1	30	G	G	G	G	G
Comparative Examples	A	16.7	0.8	0.1	25.0	26	G	P	P	P	P
	N	17.0	0.9	0.2	26.0	28	G	P	P	P	P
	B	20.6	3.2	0.6	30.6	37	P	F	F	F	P
	C	20.1	1.0	0.1	30.8	33	F	P	P	P	P

TABLE 4

		Basis Weight (g/m^2)	Reflectance (%)	Reflectance Per Unit Basis Weight (%)	Absorption Time (sec)	Appearance After Use	Backflow (g)	Spinnability and Processability	Cost Performance	Overall Judgement
Examples	3	25.2	34.9	1.4	28	G	2.4	G	G	G
	21	24.4	35.1	1.4	30	G	2.2	G	G	G
	7	16.3	21.3	1.3	29	F	3.2	G	G	F
	8	17.6	22.9	1.3	29	F	3.1	G	G	F
	10	16.0	25.3	1.6	30	F	3.2	G	G	F
	11	20.4	30.5	1.5	27	G	2.4	G	G	G
	9	32.3	42.2	1.3	29	G	2.0	G	F	G
	2	17.4	28.8	1.7	28	F	2.9	G	G	G
	12	17.0	37.0	2.2	25	G	3.0	F	G	G
Comparative Examples	D	17.2	18.0	1.0	30	P	3.1	G	G	P
	E	38.3	42.4	1.1	29	G	1.6	G	P	P
	F	17.4	40.1	2.3	31	G	3.3	P	G	P

TABLE 5

		Basis Weight (g/m^2)	Sedimentation Time (sec)	Absorption Time (sec)	Backflow (g)	Appearance After Use	Dynamic Absorption (g)	Overall Judgement
Examples	13	25.4	3.3	21	2.9	G	7	G
	3	25.2	5.6	28	2.4	G	8	G
	14	24.8	11.2	42	1.7	G	10	G
	15	24.6	18.8	50	1.3	G	7	F
Comparative Examples	G	25.6	1.8	14	4.0	F	5	P
	H	24.9	22	169	0.8	G	4	P

TABLE 6

		Basis Weight (g/m^2)	Strength (kg/50mm) MD	Strength (kg/50mm) TD	Fluffing	Reflectance (%)	Reflectance Per Unit Basis Weight (%)	Appearance After Use	Texture	Overall Judgement
Examples	3	25.2	3.0	0.6	G	34.9	1.4	G	G	G
	6	20.5	1.7	0.3	G	30.4	1.5	G	G	G
	16	25.9	3.0	0.5	E	42.0	1.6	E	E	G
	17	24.4	3.2	0.6	E	45.2	1.9	E	E	G
	18	24.9	2.1	0.4	G	43.9	1.8	E	E	G
	19	26.2	2.9	0.6	E	38.5	1.5	E	E	G
	20	25.5	3.2	0.5	E	37.8	1.5	E	E	G
Comparative Examples	I	26.1	—	—	P	—	—	—	—	P
	K	24.7	2.3	0.4	E	36.9	1.5	F	F	F

The invention has been described by way of the preferred embodiments thereof. The above-described embodiments are, therefore, intended to be merely exemplanary, and many other variations and modifications of the invention are included within the scope of the invention.

CLAIMS:

1. Liquid permeable nonwoven fabric having concealing properties which comprises short fibers, 50% by weight or more of said short fibers comprising thermoplastic fibers, and has sealed areas formed by partially sealing said nonwoven fabric in such a manner that the sealed area ratio is from 10 to 40 %,

said short fibers containing, based on 100 parts by weight of said short fibers, from 1 to 5 parts by weight of titanium oxide,

an aggregate web of said short fibers having a wettability of from 3 to 20 seconds as expressed in terms of sedimentation time, and

said nonwoven fabric having a reflectance per unit basis weight of 1.3% or more.

2. The nonwoven fabric as claimed in claim 1, wherein

said thermoplastic fibers are thermoplastic composite fibers, and

said thermoplastic composite fibers are thermally bonded together at the crossing points thereof to form said nonwoven fabric.

3. The nonwoven fabric as claimed in claim 2, wherein said sealed areas are caused to be cloudy, and said reflectance per unit basis weight is 1.4% or more.

4. The nonwoven fabric as claimed in claim 1, wherein said short fibers consist of said thermoplastic composite fibers comprising two or more of polymers different in melting point by 80 °C or more.

5. A process of producing nonwoven fabric as claimed in claim 2, comprising:

subjecting a web of said short fibers to a hot-air treatment at a temperature not lower than the melting point of the lower-melting component of said thermoplastic composite fibers and not higher than the melting point of the higher-melting component of said thermoplastic composite fibers to cause said thermoplastic composite fibers to be thermally bonded together at the crossing points thereof; and

subjecting the web to an embossing treatment at a temperature within 15 °C at or below the melting

point of the lower-melting component.

6. An absorbent article comprising a topsheet facing the wearer's skin, a liquid impermeable back sheet, and an absorbent member interposed between said topsheet and said back sheet, said absorbent article being characterized in that

said topsheet comprises the nonwoven fabric as claimed in any of claims 1 to 3.

The Patent Office

Application No: GB 9506989.4 **Examiner:** Alexander Littlejohn
Claims searched: 1-6 **Date of search:** 30 June 1995

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB2250303A	(Chisso) see whole document, e.g. page 3 lines 21,22 and page 13 lines 4,5	1-6
Y	US4892534	(Datta) see whole document, e.g. col. 5 lines 64-68, col. 6 lines 55-66	1-6
Y,P	WO94/23107A1	(Kimberly-Clark) see whole document, e.g. Examples 1 and 2 on pages 19,20	1-6
Y	WPI Abstract Accession No. 93-260897/33 & JP510076953A (Kao) 20.07.93 (see abstract)		1-6
Y	WPI Abstract Accession No. 91-084361/12 & JP030030764A (Kuraray) 08.02.91 (see abstract)		1-6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.